

Green supply management and performance

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Abstract

This study develops and empirically tests, from the resource-based perspective, a conceptual framework linking green supply management and performance. The proposed model is tested using data from a sample of 126 automotive manufactures in China. The results suggest that both green purchasing personnel and green supplier selection have a significant positive effect on green supplier collaboration, and that building green collaboration with suppliers is significantly and positively related to both environmental and operational performance. Accordingly, knowledge and skill development of the purchasing function can be recognized as an important resource in building green supply capabilities and performance.

Keywords: Green supply management; Performance; Resource-based view; China

1. Introduction

In a physically distributed environment, supply management plays an important role in enhancing competitiveness of supply chains (Ageron *et al.* 2012). Contemporary supply management aims to maintain long-term partnership with suppliers (Ho *et al.* 2010), who not only play an increasingly critical role in firm success, but they also influence considerably the total environmental impact of companies (Wagner and Johnson 2004, Darnall *et al.* 2008). It has been suggested that in order to attain the ambitions of sustainability, manufacturers must pay close attention to their upstream side of the supply chain (Paulraj 2011). Green supply management (GSM) can be defined as “the complex of mechanisms implemented at the corporate and plant level to assess or improve the environmental performance of a supplier base” (Gavronski *et al.* 2011). In recent years, there has been an increasing interest in identifying antecedents, practices and performance implications of GSM (e.g., Ageron *et al.* 2012, Vachon and Klassen 2008, Paulraj 2011, Lee et al. 2015, Gavronski *et al.* 2011). Despite this, sustainability research on supply management is still in its infancy and needs much closer attention (Ageron *et al.* 2012, Van Bommel 2011, Paulraj 2011). The expertise and knowledge of how to organize and facilitate the implementation of sustainability in supply networks is still poorly developed; sustainability seems to behave like an unknown phenomenon in supply networks (Van Bommel 2011).

Companies are under increasing pressure to integrate environmental issues into their supply chain process (Gavronski *et al.* 2011, Mohanty and Prakash 2014, Marshall *et al.* 2015, Yu *et al.* 2014). Managers have realized that they should implement environmental initiatives to assess and improve business performance from the upstream side of the supply chain. However, managers are having difficulties in developing a greener supply chain. They have little guidance on how GSM capabilities can be developed to support and implement more sustainable supply chain practices (Bowen *et al.* 2001, Gavronski *et al.* 2011, Yu *et al.* 2014). Clearly, there is still a need for more empirical research that provides useful insights for managers seeking to develop GSM capabilities. To fill the important research gap, using the resource-based view of the firm (RBV) as the theoretical background, this study develops a conceptual framework and provides an initial analysis that can help managers build GSM capabilities in order to improve sustainability performance.

GSM is a multidimensional construct, which encompasses a wide range of environmental activities (Bowen *et al.* 2001, Paulraj 2011). Previous research has collapsed the GSM construct into various dimensions, including supplier selection, supplier evaluation, environmental collaboration with suppliers, and supplier monitoring (e.g., Paulraj 2011, Gavronski *et al.* 2011, Ageron *et al.* 2012). However, many conceptualizations of GSM have not considered the central role of green purchasing personnel, and the GSM literature has paid insufficient attention to human resource management (HRM) (Gowen and Tallon 2003, Farndale *et al.* 2010). According to the RBV, knowledgeable and skilled purchasing personnel are recognized as an important human resource in building green supply capabilities (Lamming and Hampson 1996, Carter *et al.* 1998, Bowen *et al.* 2001). The purchasing function should be staffed with well-trained professionals, who possess some technical knowledge and competences (Guy and Dale 1993). Consequently, many businesses have established environmental training programs for employees in purchasing and supply management positions (Daily and Huang 2001, Daily *et al.* 2012). Furthermore, create sustainable awareness on employees through training and a well-designed reward system is important to reach sustainable goals (Zhu *et al.* 2008). Although HRM and GSM are intimately tied to each other in virtually all business scenarios (Boudreau 2004), the importance of green purchasing personnel and its effect on facilitating GSM has remained largely unexplored. With these deficiencies in mind, our study views green purchasing personnel as an important dimension of GSM. In line with previous research on GSM

(e.g., Carter *et al.* 1998, Bowen *et al.* 2001, Paulraj 2011, Ageron *et al.* 2012, Gavronski *et al.* 2011), this study recognizes and defines three main dimensions of GSM, i.e., green purchasing personnel, green supplier selection, and green supplier collaboration. More specifically, from the RBV perspective, we consider green purchasing personnel and green supplier selection as important antecedents of green supplier collaboration, which has not been empirically examined in previous work. Given a growing concern about environmental problems, identifying antecedents, practices and performance implications of GSM will offer valuable insights into the GSM literature and reveal new insights into how companies develop GSM capabilities.

In spite of the ongoing debate on the relationships between GSM practices and performance, previous research is often inconsistent and ambiguous (Rao and Holt 2005, Zhu *et al.* 2005). The mixed empirical findings in the existing literature suggest that the GSM–performance relationship needs further investigation. Accordingly, drawing upon the RBV, this study is to advance theory building within supply management by developing a theoretical framework linking GSM capabilities and performance. According to the RBV, GSM is forwarded as key organizational resources and capabilities that can lead to significant improvements in environmental and operational performance.

This study makes several compelling contributions to the supply chain research by filling important research gaps. On a theoretical front, this study recognizes green purchasing personnel as a strategic and crucial variable in facilitating GSM, which has largely been neglected in the GSM literature. Building upon the RBV, this study develops an integrative model that theoretically establishes and empirically tests (1) how manufacturers organize and facilitate the implementation of sustainability in supply management (i.e., green purchasing personnel, green supplier selection and green supplier collaboration); (2) the effects of green purchasing personnel and green supplier selection on green supplier collaboration; and (3) whether the implementation of GSM practices leads to performance improvement (i.e., operational and environmental). More specifically, we view green purchasing personnel and green supplier selection as core enablers of the establishment of environmental collaboration with suppliers. On a practical front, this study provides valuable managerial guidelines for practitioners to successfully develop GSM capabilities in order to reap the full benefits of GSM efforts.

2. Conceptual framework and hypothesis development

2.1. Resource-based view (RBV) and conceptual framework

As a theoretical background for this study, we employed the resource-based view of the firm (RBV) for theory development and hypothesis framing purposes. The RBV is an influential framework for understanding how competitive advantage, and, by extension, organizational performance, is achieved through intra-firm resources and capabilities (Corbett and Claridge 2002). The RBV focuses on the firm as the primary unit of analysis, which suggests that firms possessing rare, valuable and inimitable resources can achieve sustainable competitive advantage by implementing fresh value-creating strategies that are difficult for competitors to duplicate (Barney 1991, Peteraf 1993, Grant 1991, Wernerfelt 1984). According to the RBV, competitive advantage of a firm can be obtained and sustained over time from internal organizational resources such as assets, capabilities, processes, attributes, information and knowledge (Eisenhardt and Martin 2000). A firm's survival depends on its ability to create new resources, build on its capabilities platform, and make the capabilities more inimitable to achieve competitive advantage (Barney 1991, Peteraf 1993). Firms' resources and capabilities may be exemplified through organizational performance improvement (Sarkis *et al.* 2011). In a GSM context, building environmental cooperation with suppliers is related to better environmental and operational performance (Green *et al.* 1998, Vachon and Klassen 2008). Improving organizational performance (environmental and operational) through greening of the upstream side of the supply chain (green supply management) further supports the value, rarity, inimitability, and non-substitutability aspects of the RBV (Carter and Carter 1998, Sarkis *et al.* 2011). Accordingly, having the knowledge and capabilities for a supply chain to be green is a valuable and inimitable resource that falls well within the RBV dimensions (Lai *et al.*, 2010).

Building upon the RBV and previous research (e.g., Carter *et al.* 1998, Daily and Huang 2001, Paulraj 2011, Gavronski *et al.* 2011, Ageron *et al.* 2012, Renwick *et al.* 2013), in this study GSM is defined to encompass green purchasing personnel, green supplier selection, and green supplier collaboration. In this study, our proposed theoretical framework (see Figure 1) and constructs are grounded on the RBV, which is applied to explore how GSM capabilities can generate competitive advantage in the form of environmental and operational benefits. The conceptual model indicates that GSM capabilities are essential for achieving competitive advantage within the purview of the natural environment (Paulraj 2011). The theoretical

constructs included in the research model and their relationships are discussed in the following sections.

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2.2. Green purchasing personnel

By being located at the beginning of the forward flow of materials within the supply chain, the purchasing function is in an advantageous position to implement environmental activities such as waste reduction, recycling, reuse, and substitution of materials (Porter and van der Linde 1995, Carter *et al.* 1998). Previous research has suggested that the purchasing function plays a strategic role in helping a firm reach its sustainable development objectives (Walker and Phillips 2009). Over the last few decades, human performance and knowledge management have become increasingly important within the purchasing function (Carr and Smeltzer 2000), with the procurement personnel playing a key role in implementing environmental management practices (Carter *et al.* 1998). However, because HRM and supply chain management have been treated as separate in the literature (Gowen and Tallon 2003, Farndale *et al.* 2010), the important role of green purchasing personnel in facilitating GSM has remained largely unexplored.

In order to improve the effectiveness of the purchasing function, most companies now look for a variety of specific skills when seeking to fill a purchasing position in their organization (Carr and Smeltzer 2000). In line with previous research (e.g., Daily and Huang 2001, Renwick *et al.* 2013), this study identifies *green purchasing personnel* as green human resource management practices in the purchasing function, including skills development, motivation and involvement of purchasing employees. Research (e.g., Porter and van der Linde 1995, Carter *et al.* 1998, Zhu *et al.* 2008) has suggested that training purchasing personnel on the possibilities of green supply (e.g., the purchase of environmentally friendly products) and adequate reward and incentive system has a significant effect on environmental purchasing activities. While the level of “environmental illiteracy” among purchasing personnel is a major barrier to the implementation of GSM practices (Lamming and Hampson 1996), technical skills and competences of purchasing personnel are critical resources in building GSM capabilities (Bowen *et al.* 2001). According to the RBV, purchasing personnel with appropriate levels of industrial experience and knowledge can help companies implement environmental practices effectively (Lamming and Hampson 1996, Bowen *et al.* 2001). Bowen *et al.* (2001) further state

that a basic understanding among purchasing managers of environmental issues and how they affect supply are central to building GSM capabilities.

Although previous research from environmental sustainability (e.g., Lamming and Hampson 1996, Carter *et al.* 1998, Bowen *et al.* 2001, Walker and Phillips 2009) has identified purchasing personnel factors (such as environmental training, employee empowerment, teamwork, and rewards systems) as key elements for supply management practice implementation, to our knowledge, there has been no previous research studying the link between green purchasing personnel and green supplier collaboration practices. The RBV proposes that purchasing personnel factors offers firms resources that are valuable, rare, and difficult to imitate or substitute (Barney 1991, Peteraf 1993). In line with the RBV, we argue that a purchasing function that possesses well developed and green-oriented sourcing skills can help manufacturers build environmental collaboration with suppliers, who adopt sustainable innovations in their operations (Green *et al.* 1998, Walton *et al.* 1998, Mahler 2007). The environmental training of purchasing employees and a well-designed reward system can be helpful in promoting employees to perform sound environmental practices and in enhancing a company's capacity to build environmental collaboration with suppliers (Daily and Huang 2001). The discussion forms the basis of the following hypothesis.

H1: Green purchasing personnel has a positive effect on green supplier collaboration.

2.3. Green supplier selection

One of the most important green supply chain management (GSCM) practices is to address environmental considerations in supplier selection, maintenance, and development, which has attracted more and more attention in the literature (Dekker *et al.* 2012, Igarashi *et al.* 2013, Kannan *et al.* 2014, Luthra *et al.* 2015). Previous research has identified that including environmental considerations in supplier selection is a fundamental practice among organizations that strive for sustainability (Paulraj 2011, Gavronski *et al.* 2011, Ageron *et al.* 2012, Lee *et al.* 2015, Dekker *et al.* 2012, Igarashi *et al.* 2013). Green supplier selection should be considered when companies are looking for greener supply chain management (Xiong *et al.* 2013). Addressing the environmental criteria during supplier selection process has become a crucial issue because hazardous substances contained in raw materials provided by suppliers may cause serious environmental impact in the supply chain, and because a firm's environmental

sustainability and ecological performance can be demonstrated by its suppliers (Kuo *et al.* 2010, Igarashi *et al.* 2013, Kannan *et al.* 2014). The supplier process has become more complicated when environmental issues are considered (Lee *et al.* 2009). This is because green selection must consider the supplier's environmental responsibility, in addition to the traditional criteria of price, quality, delivery, and services (Handfield *et al.* 2005, Lee *et al.* 2009). Chen (2005) identifies two-stage supplier selection, i.e., (1) environmental performance as the minimum requirement and (2) general purchase practices such as quality, delivery, and performance records. More specifically, Chen suggests that only the suppliers that have ISO14000 certification can be included in the second-stage evaluation.

There have been recently an increasing number of studies that have addressed supplier selection issues in green supply chains from an environmental sustainability perspective (e.g., Hsu and Hu 2009, Lee *et al.* 2009, Kuo *et al.* 2010, Xiong *et al.* 2013, Kannan *et al.* 2014). Most of these studies, though, have focused on multi-criteria decision-making approaches (such as analytic hierarchy process (AHP), analytic network process (ANP), data envelopment analysis (DEA), and mathematical programming) rather than survey-based research like the present study. The RBV views strategic purchasing as an important resource that enables firms to develop supply management capabilities (Barney 1991, Peteraf 1993). From a supply chain perspective, previous studies have indicated the positive link between strategic purchasing and supply management capabilities (e.g., close relationships with suppliers, long-term orientation, and communication). For instance, Carr and Smeltzer (1999) document how firms with strategic purchasing can foster long term, cooperative relationships and communication, and achieve greater responsiveness to the needs of their suppliers. Strategic purchasing is considered critical to fostering and facilitating close interactions and communication with upstream suppliers, which is critical to achieving effective integration throughout the supply chain (Cox 1996, Cousins 1999). More specifically, Chen *et al.* (2004) find that strategic purchasing plays a critical role in engendering long-term, close working relationships and strategic cooperation with suppliers, and maintaining open, two-way communication and knowledge exchange between the focal firm and its suppliers. However, from a GSCM perspective, to the best of our knowledge, there is no empirical study exploring the role of green supplier selection in establishing environmental cooperation with suppliers. Supplier selection plays an important role in making a supply chain green (Rao 2002). After selecting suitable suppliers, it is important to manage them using a

strategic and collaborative mindset, i.e., building environmental collaboration with suppliers (Paulraj 2011). From the RBV perspective, strategic green purchasing can be viewed as valuable company assets, which may build GSM capability that is difficult to replicate by competitors and improve environmental collaboration with suppliers. Accordingly, consistent with the RBV, we argue that green supplier selection contributes to build long-term strategic environmental cooperation between the firm and its suppliers. Thus, we posit the following hypothesis.

H2: Green supplier selection has a positive effect on green supplier collaboration.

2.4. Green supplier collaboration and performance

Green supplier collaboration is defined as environmental collaboration between a focal firm and its suppliers in implementing environmental management practices (Walton *et al.* 1998, Vachon and Klassen 2008). It focuses on the inbound or upstream segment of a product's and organization's supply chain (Zhu and Cote 2004). Suppliers are the vendors who provide raw materials, components or services that an organization cannot self produce (Kuo *et al.* 2010). Suppliers are considered as the crucial partners in supply chains as they can be in a position to support the environmental initiatives of the organisations and provide assistance in improving environmental performance of supply chains (Bowen *et al.* 2001, Seuring and Muller 2008, Lee *et al.* 2015, Luo *et al.* 2014). For the implementation of environmentally friendly practices, companies should include their suppliers for purchasing processes and materials management, which are as good as greening their suppliers (Walton *et al.* 1998, Rao and Holt 2005). Companies are increasingly managing their suppliers' environmental performance ensuring that the materials and process suppliers use are environmentally friendly (Rao and Holt 2005).

The RBV can help justify investment in upstream suppliers within supply chains to create competitive advantage (Rungtusanatham *et al.* 2003). According to the RBV, where there are resource constraints, collaboration provides firms with an opportunity to gain access to complementary capabilities (McIvor, 2009). Environmental collaboration with suppliers contributes to competitive advantage and business success (Vachon and Klassen, 2008). From the "inbound" perspective of the supply chain it is argued that greening the supply chain has numerous benefits to an organization, ranging from cost reduction to integrating suppliers in a participative decision-making process that promotes environmental innovation (Bowen *et al.* 2001, Rao 2002, Hall 2003). Consistent with the RBV, it is argued that environmental

cooperation with suppliers is important to environmental and operational performance (Darnall *et al.* 2008). Walton *et al.* (1998) suggest that companies need to involve suppliers and purchasers in improving the environmental performance of the whole supply chain, and thus addressing the purchasing function's impact on the environment. Walton *et al.* further find that supplier cooperation can help organization reduce emissions and monitor the waste streams from suppliers. Similarly, Zhu and Sarkis (2004) also find empirical evidence that the implementation of external GSCM practices such as cooperation with suppliers for environmental objectives is significantly and positively related to environmental performance. A recent study by Lee *et al.* (2015) also identifies a significant positive relationship between greening the supplier and environmental performance.

With regard to the effect of green supplier collaboration on operational performance, it has been argued that the involvement and support of suppliers is crucial to achieving benefits such as reduction of waste produced, material substitution through environmental sourcing of raw materials, and waste minimization of hazardous materials, which in turn can also yield improved operational performance (Walton *et al.* 1998, Dey and Cheffi 2013, Zhu *et al.* 2005, Vachon and Klassen 2008, Zailani *et al.* 2012) For instance, Vachon and Klassen (2008) find that collaboration with suppliers on environmental issues is linked to improved manufacturing performance such as quality, delivery and flexibility. Yang *et al.* (2010) also find that environmental management programmes, including some aspects of supplier collaboration, have a positive and significant impact on manufacturing competitiveness such as cost and delivery. Considering the RBV and the above empirical evidences, we argue that green supplier collaboration can be a source of competitive advantage with regard to environmental performance and operational performance. Thus, we propose the following hypotheses.

H3: Green supplier collaboration is positively related to environmental performance.

H4: Green supplier collaboration is positively related to operational performance.

3. Data and method

3.1. Sample and data collection

We tested our theoretical model in the context of China's automotive industry for several main reasons. First, the automobile industry, as a networked industry, is in an advanced stage of implementing supply management (Benton and Maloni 2005). Automotive production is one of the most complex and diverse manufacturing activities in the world as an automobile is composed of approximately 15,000 parts, which requires a high degree of outsourcing to suppliers for their assembly (Shin *et al.* 2000, Simpson and Power 2005, Oliver *et al.* 2008). It is virtually impossible for an individual firm in the automotive industry to possess all the technical expertise and capabilities needed to develop and produce a complex product like a car (Wagner *et al.* 2009, Lockstrom *et al.* 2010). Effective supply management such as buyer–supplier partnership management and supplier collaboration is critical to success in the automotive industry (Lettice *et al.* 2010, Lockstrom *et al.* 2010). Second, the auto industry is one of the high energy consuming industries and key polluting industrial sectors in China (Zhu *et al.* 2011a, Zhu *et al.* 2007). The automotive industry is characterized with relatively higher levels of resource consumption, waste production, and CO₂ emissions (Luthra *et al.* 2015, Zhu *et al.* 2011b). Increasing pressures from different stakeholder groups (e.g., government and customers) have caused Chinese automakers to consider and adopt GSCM practices to improve firm performance (Zhu *et al.* 2007). Due to global supply chain involvement, Chinese automotive component suppliers are now bound by international policies and regulations if their products are targeted for export to overseas markets (Zhu *et al.* 2011a). More international automotive manufacturers have established real or anticipated requirements for their suppliers. For example, Ford, GM and Toyota have required their Chinese suppliers to obtain ISO14001 certification (GEMI 2001, Ageron *et al.* 2012). Implementing GSM practices has become an emergent ecological modernization tool for Chinese automakers to balance environmental performance with productivity and business performance gains (Zhu *et al.* 2007, Zhu *et al.* 2011a). Thus, given these two main elements and given our research objectives, China's automotive industry provides a particularly interesting context for our study to clarify how to develop GSM capabilities for performance improvement.

A random sample of 1,000 manufacturing plants (e.g., automakers and first- and second-tier automotive suppliers) was drawn from the 2010/2011 directory of China's

automotive industry manufacturers, which was jointly edited by the Wheelon Autoinfo, China Association of Automobile Manufacturers (CAAM), and Society of Automotive Engineers of China (SAEC). The directory is the official China automotive industry user's guide. Geographically, survey respondents comprise firms in a number of regions and provinces, e.g., Chongqing and Sichuan province, Shanghai and Jiangsu province, Hubei province, and Guangdong province. According to CAAM (2013), most large automobile manufacturing bases in China are located in these geographic areas. For each randomly selected automotive manufacturer, with the help of personal connections with automakers and industrial authorities, we identified key informants to obtain their preliminary agreement to participate (Dillman 2000). The questionnaires were sent to 600 informants that agreed to participate in our study. Our respondents typically had a title such as general manager, directors, supply chain manger, operations manager, and sales and marketing managers. Most of our respondents were corporate managers with an average of more than eight years of work experience in the same company, and thus is reasonable to expect that the respondents could offer a deep insight into the green supply chain initiatives and be knowledgeable about their respective firms so as to ensure the quality of the collected data.

Following previous studies on survey research (e.g., Dillman 2000, Frohlich, 2002), we employed several steps to maximize the response rate and minimize response bias in subjective data obtained from the respondents. First, since the measurement scales adapted from the literature were in English, the original scales were first developed in English and then translated into Chinese, in order to ensure the reliability of the questionnaire (Zhao *et al.* 2011, Yu *et al.* 2013). A number of questions were reworded to improve the accuracy of the translation and to make it relevant to environmental management practices in China. To further assess the reliability and validity of the measurement items, we sent the questionnaire to academics from the field of operations and supply chain management for review, and then pilot-tested it with six supply chain and production managers at automakers in China (O'Leary-Kelly and Vokurka 1998). Based on the feedback from academics and industrial experts, we modified the wording of some questions. Second, each questionnaire was accompanied by a cover letter indicating the purpose of the study and potential contributions. The letter also assured complete confidentiality to the respondents. Third, follow-up calls were made to encourage completion and return of the questionnaires and to clarify any questions that potentially had arisen (Frohlich 2002). After

several reminders by phone calls and emails, we received 126 completed and useable questionnaires. The response rate was 21%, which can be regarded as satisfactory in this type of survey-based study (Frohlich 2002). A profile of the respondents is reported in Table 1.

-----Table1-----

3.2. Non-response bias and common method bias

To examine the possible non-repose bias and the generalizability of findings to the population, following Armstrong and Overton (1977), we conducted a *t*-test to check whether there is any significant difference on demographic characteristics of annual sales and number of employees between early and late responses. The *t*-test results indicate no significant statistical differences ($p < 0.05$), which suggests that received questionnaires from respondents represent an unbiased sample.

Because the data for this study were collected from single respondents, we used three main steps to assess the potential for common method bias (Podsakoff *et al.* 2003). First, Harmon's one-factor test using exploratory factor analysis (EFA) was conducted (Podsakoff *et al.* 2003). The EFA results revealed four distinct factors with eigenvalues above 1.0, explaining 64.619% of total variance. The first factor explained 37.500% of the variance, which is not majority of the total variance. Second, we performed confirmatory factor analysis (CFA)-based Harman's single-factor test (Podsakoff *et al.* 2003, Zhao *et al.* 2011, Yu *et al.* 2013). The model fit indices (χ^2/df (774.392/209) = 3.705, CFI = 0.607, IFI = 0.613, TLI = 0.565, RMSEA = 0.147) were unacceptable and were significantly worse than those of the measurement model. This suggests that a single factor model is not acceptable, thus common method bias is unlikely. Third, a latent factor representing a common method was added to the measurement model, which is the strongest test of common method bias (MacKenzie *et al.* 1993, Podsakoff *et al.* 2003). The resulting fits were not significantly different from those of the measurement model (RMSEA = 0.048 vs. 0.041 for the model with the common method factor; CFI = 0.960 vs. 0.974; IFI = 0.961 vs. 0.975; TLI = 0.954 vs. 0.966). Also, the item loadings for their factors are still significant in spite of the inclusion of a common latent factor. Based on the results, we conclude that common method variance bias is not an issue in this study.

3.3. Measures

An extensive literature review was conducted to identify valid measures for our theoretical constructs. The measures we used and their sources are reported in Table 2. The measures for green purchasing personnel were mainly adapted from green supply research (e.g., Carter *et al.* 1998, Bowen *et al.* 2001, Daily and Huang 2001), which emphasized environmental training, motivation, and involvement of purchasing employees. The green supplier selection scale was adapted from Zhu *et al.* (2010) and Gavronski *et al.* (2011), which included choosing suppliers using environmental criteria, environmental audit for suppliers' internal management, requiring suppliers to have environmental management certification (e.g., ISO14000/ISO14001), and first-tier supplier environmentally friendly practice evaluation. We used scales from Vachon and Klassen (2008) and Zhu *et al.* (2010) to measure green supplier collaboration, which focused on building environmental collaboration with upstream suppliers. A five-point scale (where 1 = no plan to implement and 5 = full implementation) was used for all measures. We defined benefits gained through GSM as improvements in environmental performance (Zhu *et al.* 2010) and operational performance (Flynn *et al.* 2010, Wong *et al.* 2011, Lai and Wong 2012). Our respondents were asked to evaluate their performance relative to the performance of main competitors over the last three years. The indicators were measured using a five-point Likert scale (ranging from 1 "much worse than competitors" to 5 "much better than competitors"), where higher values indicated better performance.

4. Data analysis and results

Following a two-step approach (measurement model and structural model) recommended by Anderson and Gerbing (1988), this study used structural equation modelling (SEM) with AMOS 21 to estimate the conceptual model.

4.1. Measurement model

Based on the CFA results summarized in Table 2, we conclude that the unidimensionality is confirmed (Hu and Bentler 1999, Kline 2005). As shown in Table 2, the Cronbach's alpha coefficient and composite reliability of the constructs well exceed the widely recognized rule of thumb of 0.70 (Nunnally 1978, Fornell and Larcker 1981, O'Leary-Kelly and Vokurka 1998). Thus, we conclude that our theoretical constructs exhibit adequate reliability.

We evaluated the convergent validity of each measurement scale by conducting CFA using the maximum likelihood approach (O’Leary-Kelly and Vokurka 1998). As shown in Table 2, all indicators in their respective constructs have statistically significant ($p < 0.001$) factor loadings greater than 0.50, which indicate convergent validity of the theoretical constructs (Anderson and Gerbing 1988). Additionally, the CFA results also reveal that the standardized coefficients for all items are greater than twice their standard errors and that the t-values are all larger than 2 (Flynn *et al.* 2010, Zhao *et al.* 2011), which further demonstrate convergent validity. Furthermore, the average variance extracted (AVE) of each construct exceeds or is marginally below the recommended minimum value of 0.50 recommended by Fornell and Larcker (1981), which indicates strong convergent validity. Based on these results, we conclude that the constructs and scales have convergent validity.

-----Table2-----

Discriminant validity was examined by comparing the correlation between the construct and the square root of AVE. Discriminant validity is indicated if the AVE for each multi item construct is greater than the shared variance between constructs (Fornell and Larcker 1981). Table 3 indicates that the square root of AVE of all the constructs is greater than the correlation between any pair of them, which provides evidence of discriminant validity (Fornell and Larcker 1981).

-----Table3-----

4.2. Structural model

The results of hypotheses tests using SEM are reported in Table 4. The overall fit indices of the structural model are χ^2/df (294.275/204) = 1.443, RMSEA = 0.059, CFI = 0.937, IFI = 0.938 and TLI = 0.929. Thus, the model was acceptable (Hu and Bentler 1999, Kline, 2005). The structural model indicates that green purchasing personnel and green supplier selection have a significant positive effect on green supplier collaboration, which lends support for H1 and H2. Table 4 also shows that green supplier collaboration is significantly and positively related to both environmental and operational performance. Thus, H3 and H4 are supported.

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5. Discussion and implications

From a green supply chain perspective, this study contributes to and extends a growing research stream investigating the important role of GSM in supply chain success in several important ways. First, sustainability research on supply management is still in its infancy and much more research needs to be done. This study aims to fill this important research gap by collapsing GSM into three main dimensions, including green purchasing personnel, green supplier selection, and green supplier collaboration. Second, conceptualizing green purchasing personnel as an important dimension of GSM also fills another research gap, i.e., the existing GSM literature has paid insufficient attention to HRM. Our findings provide empirical evidence of the importance of including green purchasing personnel in developing GSM patterns, which is consistent with the key propositions of RBV. Third, drawing upon the RBV, we evaluated green purchasing personnel and green supplier selection as key antecedents to green supplier collaboration and performance, which has not been empirically examined in previous work. Our findings establish the significant positive effects of green purchasing personnel and green supplier selection on green supplier collaboration, which in turn leads to improved environmental and operational performance. On a practical front, this study provides useful guidance for managers to decide how to devote their efforts and likely limited resources to the different dimensions of GSM for performance improvement, especially in the Chinese automotive industry. Chinese automobile manufacturers can improve their environmental and operational performance through the development of GSM capabilities. Thus, drawing upon the RBV, by developing and empirically testing an integrated theoretical model linking GSM and performance, this study makes a significant contribution to the GSM literature and has important implications for practice. We discuss the theoretical and managerial implications in the following sections.

5.1. Theoretical implications

Supply chain management and human resources have a long history of separateness (Gowen and Tallon 2003, Farndale *et al.* 2010). As such, the GSM literature has paid insufficient attention to HRM. Our findings provide preliminary evidence of the importance of including green purchasing personnel in developing GSM patterns, as well as establishing a significant positive relationship between green purchasing personnel and green supplier

collaboration. This finding is consistent with the fundamental principles of the RBV. According to the RBV, green purchasing personnel is an important human resource factor that influences the establishment of environmental collaboration with suppliers, without which companies are unable to reap the full benefits of their GSM efforts. This is an important finding because much of the extant literature on supply management does not include purchasing personnel as a dimension of GSM. In today's dynamic environment, the technological changes and competitiveness have forced companies to become more sophisticated when identifying and recruiting personnel to fill purchasing and supply management positions (Carr and Smeltzer 2000). Our finding indicates that the purchasing function should be staffed with well-trained professionals who possess technical knowledge and skills, which will help manufacturers create long-term environmental collaboration with suppliers. Given the significance of human capital and manpower in generating a wealth of knowledge, purchasing employees must be empowered to approach sustainability initiatives through green human resource management practices such as environmental training and rewards systems (Daily and Huang 2001, Renwick *et al.* 2013). More importantly, such green personnel management can enable manufacturers to significantly involve upstream suppliers in collaborative sustainability initiatives that can lead to improved operational and environmental performance. These results also provide compelling empirical support for incorporating insights from the RBV perspective into the GSM literature. From the RBV perspective, this study identifies green human resource factors such as environmental training, employee involvement, and rewards systems as critical resources for building GSM capabilities. GSM may be less than completely successful if green purchasing personnel is not addressed (Daily and Huang 2001).

The findings of the significant positive relationship between green supplier selection and green supplier collaboration constitute a significant contribution to the supply management literature. In the operations and supply chain management literature, researchers (e.g., Carr and Smeltzer 1999, Chen *et al.*, 2004) have documented how strategic purchasing fosters cross-functional integration among supply chain activities. Although the role of strategic purchasing in promoting cross-functional, intra-organizational relationships has been relatively well documented (Ellram and Carr 1994, Chen *et al.* 2004), its role in building environmental collaborative relationships between a focal firm and its suppliers has not yet been rigorously investigated. Therefore, from the RBV perspective, our study takes a significant step toward

filling this research gap in the context of green supply chains. Addressing the environmental criteria during the supplier selection process plays a critical role in fostering long-term and close working relationships and strategic environmental cooperation with suppliers, and establishing and maintaining open knowledge exchange between automotive manufacturers and their suppliers. By promoting long-term environmental collaboration between the automaker and its suppliers, green supplier selection can foster greater commitment and trust, which are central to GSM (Chen *et al.* 2004, Luo *et al.* 2014). Selecting suitable and green suppliers in the supply chain has become a key strategic consideration, which can facilitate supplier integration in sustainability initiatives that can help in generating and sustaining competitive advantage (Hunt and Davis 2008, Paulraj 2011).

Furthermore, GSCM researchers (e.g., Lai and Wong 2012, Dey and Cheffi 2013) have documented environmental activities and practices and their impact on firm performance. However, the literature provides mixed support for this relationship (Rao and Holt 2005, Zhu *et al.* 2005). Our finding of a significant positive relationship between green supplier collaboration and performance (environmental and operational) provides empirical support for the fundamental principles of the RBV of competitive advantage. According to the RBV, GSM practices are important organizational resources and capabilities that can enable firms to achieve superior operational and environmental performance. More specifically, our results indicate that the impacts of green purchasing personnel and green supplier selection on environmental and operational performance are indirect through green supplier collaboration. The result of green supplier collaboration significantly related to performance is consistent with the findings of previous studies (e.g., Lee *et al.* 2015, Vachon and Klassen 2008). Green supplier collaboration allows the automobile manufacturer to be rapidly updated on the progress of its orders at the supplier's plant and to decide jointly with the supplier the most appropriate plan modifications in order to accommodate final customer requests (Danese and Romano 2011). Hence, building environmental collaborative relationships with suppliers is essentially linked to both operational and environmental performance. The findings make some theoretical sense because green supplier collaboration is the more elaborate of the GSM capabilities (Gavronski *et al.* 2011). From the RBV perspective, green supplier collaboration is a cross-boundary capability that plays an invaluable role in helping manufacturers achieve sustainable competitive advantage (Min and Galle 2001, Paulraj 2011).

Our findings extend prior supply chain research by indicating the importance of GSM practices in the context of China's automotive industry. Previous related research has focused on other contexts including France (Ageron *et al.* 2012), Canada (Gavronski *et al.* 2011) and the USA (Paulraj 2011). Further, unlike previous studies that examined GSCM practices in the Chinese manufacturing industry (e.g., Zhu *et al.* 2007, Zhu *et al.* 2010, Zhu *et al.* 2012, Zhu and Sarkis 2004), our study focuses on the upstream side of the supply chain, i.e., green supply management. More specifically, by conceptualizing GSM as a multidimensional construct, our study views HRM (i.e., green purchasing personnel) as an important dimension of GSM and explores its impact on green supplier collaboration, which has not been empirically examined in Zhu *et al.*'s work. Thus, the present study is unique in that it examines GSM capabilities in the Chinese automobile industry. In the context of our study, China's automotive industry, the world's largest automobile market, has been experiencing unprecedented development over the past decade (Zhu *et al.* 2007, CAAM 2013). However, Chinese automakers are under increasing environmental pressures from major stakeholder groups such as government to both implement GSM practices and reduce environmental harms caused by their operations and supply chains (Zhu *et al.* 2007, Zhu *et al.* 2010, Zhu *et al.* 2012). As the environment continues to worsen, the Chinese government has begun to pay increasing attention to ecological and environmental protection. For example, the Chinese government plans to pump in investments and subsidies to boost the development and production of green vehicles (BBC 2011, Yap 2012). Our study identifies that GSM has become an emergent ecological modernization tool for Chinese automakers to obtain environmental and operational benefits. Chinese automobile manufacturers can improve their business performance through implementing important dimensions of GSM practices, such as green purchasing personnel, green supplier selection and green supplier collaboration.

5.2. Managerial implications

The findings of our study offer useful implications for managers and purchasing and supply professionals. First, managers can develop GSM capabilities that incorporate the development of green purchasing personnel, green supplier selection, and green supplier collaboration. Managers may also learn how to develop specific organizational resources and capabilities that can facilitate the implementation of GSM practices. Most of all, managers must

remember that green human resource factors may be significant predictors of success or failure in environmental improvement efforts (Daily and Huang 2001). Competing in today's dynamic market, firms that seek to build GSM capabilities should implement green human resource management practices in the purchasing function, including establishing environmental training programs and rewards systems for employees that strengthen skills development, motivation and involvement of purchasing employees.

Second, another significant insight from this research is that managers should set priorities for the development of GSM capabilities. Our study reveals that green purchasing personnel and green supplier selection can act as important enablers for building environmental collaboration with suppliers. This finding suggests that firms should invest first (or simultaneously) in green purchasing personnel and green supplier selection, which will help firms build long-term and strategic environmental cooperation with suppliers for performance improvement. Besides green purchasing personnel, green supplier selection should also be considered when companies build GSM capabilities. Automotive manufacturers should integrate environmental criteria into their supplier selection process, for example, requiring suppliers to obtain ISO14001 certification. As the important dimensions of GSM, green purchasing personnel and green supplier selection, are critical factors fostering greater environmental collaboration with suppliers.

Third, our findings reveal a significant positive effect of green supplier collaboration on performance, which provides useful guidelines to managers for devoting relevant resources to achieve better green supplier collaboration. Managers should understand how firms could involve suppliers in GSM practices and engage them into cooperation in green activities, which is a key relational capability that can result in significant improvements in organizational sustainability. When developing GSM capabilities, more attention should be given to creating strategic environmental cooperation with suppliers since it is green supplier collaboration that directly influences both environmental and operational performance. Building collaborative relationships with suppliers helps manufacturers reduce industrial hazards and wastes and environmental accidents across supply chain partner firms through information sharing and joint planning.

6. Conclusions and directions for future research

From the RBV perspective, our study extends previous supply management research by developing and empirically testing a theoretical model linking GSM and performance. It makes significant contributions to the GSM literature and has important implications for practice. First, in line with the RBV, we conceptualized green purchasing personnel as an important dimension of GSM, and found that green purchasing personnel has a significant positive effect on green supplier collaboration. This is an important finding since the GSM research has paid insufficient attention to HRM. Second, this is the first study to investigate the effect of green purchasing personnel and green supplier selection on green supplier collaboration. We found that both green purchasing personnel and green supplier selection are positively related to green supplier collaboration, which in turn leads to improved business performance. Third, we found that all our hypotheses are supported, which indicates that the proposed model is empirically supported by the survey data in the context of China's automotive industry. China is now playing an increasingly important role in today's global automotive supply chain. How Chinese automotive manufacturers respond to the increasing environmental issues in the supply chain that is quite challenging to manage has become a critical concern on developing GSM capabilities. This study provides useful and timely insights into GSM in the Chinese automotive industry.

The limitations of the study are provided with the ambition of discussing opportunities for further research. Our study is parsimonious in nature and includes only three main dimension of GSM. However, it should be noted that GSM is a multidimensional construct. Previous research (e.g., Paulraj 2011, Gavronski *et al.* 2011) has collapsed GSM construct into various dimensions, such as supplier evaluation and monitoring. Thus, future researchers may include other factors within the domain of GSM capabilities. Second, our study focused on examining the sustainability on the upstream side of the supply chain (i.e., supply management). Previous research has suggested that sustainable supply chains deal with environmental or green issues in both forward and reverse flows through both upstream and downstream sides of the supply chain (Rao and Holt 2005). We therefore encourage future researchers to pay equal attention to the downstream side of the supply chain, and investigate the effect of buyer-supplier partnership management on the development of GSM capabilities using mediation and/or moderation analysis. Third, although the focus of a single industry has its own advantages, omitting other industries may bias the sample and limit generalizability of the results (Wong *et al.* 2011). Thus,

future research should empirically test the applicability and also confirm the results obtained in this study in different industries and countries. Fourth, human resources principles and supply chains are inextricably linked in most business scenarios (Boudreau 2004). The present study views green purchasing personnel as an important dimension of GSM and examine its impact on developing GSM capabilities. Future research may investigate other human capital factors and its importance in facilitating the implementation of GSM practices. Despite these limitations, this study paves the way for researchers and managers to more fully understand the nature of the GSM–performance link.

Acknowledgements

This research is supported in part by the National Natural Science Foundation of China (NSFC) under Grant Number 71401019 and China Scholarship Council 201372

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Table 1: Demographic characteristics of respondents

	Number of firms	Percentage of samples (%)
Automotive industry		
Automaker	38	30.2
First-tier supplier	68	54.0
Second-tier supplier	12	9.5
Others	8	6.3
Total	126	100.0
Annual sales (in million Yuan)		
Below 10	2	1.6
10-50	12	9.5
50-100	16	12.7
100-500	32	25.4
500-1,000	14	11.1
More than 1,000	50	39.7
Number of employees		
1-99	5	4.0
100-199	16	12.7
200-499	32	25.4
500-999	13	10.3
1,000-4,999	33	26.2
5,000 or more	27	21.4

Table 2: Construct reliability and validity analysis

Construct	Factor loadings	t-value	Reliability and validity
1. Green purchasing personnel (Carter <i>et al.</i> , 1998; Daily and Huang, 2001)			$\alpha = 0.846$; CR = 0.853; AVE = 0.662
Purchasing personnel introduce environmental issues to suppliers	0.702	–	
Purchasing personnel receive training regarding the purchase of environmentally friendly products	0.869	8.835	
Purchasing personnel are evaluated based on their levels of environmental activities	0.859	8.757	
2. Green supplier selection (Zhu <i>et al.</i> , 2010; Gavronski <i>et al.</i> , 2011)			$\alpha = 0.824$; CR = 0.825; AVE = 0.542
Environmental audit for suppliers' internal management	0.734	–	
Suppliers' ISO14000/ISO14001 certification	0.681	7.244	
First-tier supplier environmentally friendly practice evaluation	0.811	8.614	
Suppliers are selected using environmental criteria	0.713	7.588	
3. Green supplier collaboration (Zhu <i>et al.</i> , 2010; Vachon and Klassen, 2008)			$\alpha = 0.808$; CR = 0.828; AVE = 0.554
Cooperation with suppliers for environmental objectives	0.734	–	
Adopt just-in-time logistics system for supplier cooperation	0.511	5.451	
Conducting joint planning with suppliers to anticipate and resolve environmental-related problems	0.840	9.030	
Making joint decisions with suppliers about ways to reduce overall environmental impact of our products	0.842	9.051	
4. Environmental performance (Zhu <i>et al.</i> , 2010)			$\alpha = 0.899$; CR = 0.901; AVE = 0.646
Reduction of waste water	0.744	–	
Reduction of solid wastes	0.857	9.588	
Decrease in consumption for hazardous/harmful/toxic materials	0.811	9.055	
Decrease in frequency for environmental accidents	0.808	9.022	
Improve a company's environmental situation	0.794	8.856	
5. Operational performance (Flynn <i>et al.</i> , 2010; Wong <i>et al.</i> , 2011; Lai and Wong, 2012)			$\alpha = 0.828$; CR = 0.837; AVE = 0.468
Quickly respond to changes in market demand	0.602	–	
The capability to make rapid product mix changes	0.663	5.915	
An outstanding on-time delivery record to our customer	0.816	6.783	
The lead time for fulfilling customers' orders is short	0.776	6.585	
Provide a high level of customer service	0.690	6.088	
Reduce waste in production processes	0.509	4.821	
Model fit statistics: χ^2/df (256.025/199) = 1.287; RMSEA = 0.048; CFI = 0.960; IFI = 0.961; TLI = 0.954			

Table 3: Descriptive statistics

	Mean	S.D.	1	2	3	4	5
1. Green purchasing personnel	3.550	0.855	0.814 ^a				
2. Green supplier selection	3.603	0.761	0.674**	0.736			
3. Green supplier collaboration	3.754	0.728	0.637**	0.709**	0.744		
4. Environmental performance	3.660	0.699	0.331**	0.271**	0.275**	0.804	
5. Operational performance	4.013	0.605	0.521**	0.464**	0.348**	0.497**	0.684

Note: ^a Square root of AVE is on the diagonal.

** $p < 0.01$. (2-tailed).

Table 4: Results of hypotheses 1–4 tests using SEM

Structural paths	Standardized coefficient	t-value	Hypothesis test
Green purchasing personnel → green supplier collaboration (H1)	0.359*	2.425	Supported
Green supplier selection → green supplier collaboration (H2)	0.565***	3.569	Supported
Green supplier collaboration → environmental performance (H3)	0.371***	3.605	Supported
Green supplier collaboration → operational performance (H4)	0.504***	4.284	Supported

Model fit statistics: χ^2/df (294.275/204) = 1.443; RMSEA = 0.059; CFI = 0.937; IFI = 0.938; TLI = 0.929

*** $p < 0.001$; * $p < 0.05$.

Figure 1: Research model

